Exhaust emission analysis on engine using biodiesel produced from broiler slaughter waste

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Abstract—**In this work, exhaust gas emission analysis was conducted for standard diesel, pure biodiesel, diesel (90%)+biodiesel (10%)-B10, diesel(80%)+biodiesel(20%)-B20, diesel(70%)+biodiesel(30%)-B30. Here the biodiesel used is produced from the broiler chicken waste. Experiments are carried out using single-cylinder, 4-stroke, direct injected, water-cooled diesel engine at five loads between no load and a full load of 1500 rpm. Emission characteristics of the engine fueled with biodiesel and its blends with diesel were compared to standard diesel fuel as the baseline fuel. Overall, biodiesel blends, as compared to diesel, reduce NO, CO, CO_2 and HC emissions, at full loads. It is also shown that biodiesel and its blends having less EGT than diesel fuels.**

Keywords— **exhaust gas emission, biodiesel and its blends(B10, B20, B30, B100), diesel fuel, comparison.**

INTRODUCTION

Internal combustion engines generate undesirable emissions during the combustion process. The emissions exhausted into the surroundings pollute the atmosphere and causes global warming, acid rain, smog, odours, respiratory and health hazards.

Biodiesel is one of the most used renewable energy sources for diesel engines. Increasing dependence on petroleum products, the energy crisis, global climate change and environmental pollutions are focused on the investigations on renewable energy sources. Biodiesel, an alternative diesel fuel, is made from renewable biological sources such as vegetable oils and animal fats. It is biodegradable and nontoxic, has low emission profiles and so is environmentally beneficial Biodiesel blends can be used in diesel engines without any major modification.

Rendered chicken oil (RCO) produced from broiler slaughter waste by dry rendering process, is a cheap raw material. Its low operating cost in biodiesel production make this study a promising one for possible green technological applications. The rendered chicken oil with high Free fatty acid (FFA) could be converted to good quality biodiesel by two-step process viz. acid catalysed esterification of FFA followed by alkali catalysedtransesterification of triglycerides. Chicken oil methyl ester blended with diesel fuel could be used as an alternative fuel in conventional diesel engines without any major modifications[1].

OBJECTIVES

- To check the properties of the chicken waste biodiesel.
- To evaluate the emission rates of different biodiesel blends such as B10, B20, B30, B100.
- Compare the emissions of blends with diesel fuel.

EXPERIMENTAL SETUP

1. PROPERTIES

Viscosity

Viscosity is an important property needed for a fuel which determines the performance of the engine. If the fuel viscosity is extreamely excessive, there will be degradation of the spray in the cylinder causing poor atomisation, contamination and the production of black smoke. The viscosity of chicken fat biodiesel and its blends are measured using Brookfield Viscometer which satisfies ASTM standard. The obtained values are, for B00 (diesel) – 2.14 centi poise (cP), B10 – 2.2 cP, B20 – 2.44 cP, B30 – 2.6 Cp, B100 – 4.18 Cp. This value is within ASTM standard value for viscosity (1.9-6.0 cP).

Density

Density is Engine performance related property which is defined as the mass per unit volume(kg/ m3. This property influences the nozzle opening and injection timing of the fuel into the engine. The value for density was measured by a hydrometer. The obtained value for chicken fat biodiesel B00 (diesel) – 820 kg/m3, B10 – 822.5 kg/m3, B20 - 825 kg/m3 B30 – 832.5 kg/m3. B100- 804.3 kg/m3.

Flash point

The temperature at which the vapour of a liquid flash when subjected to a naked flame is known as the flash point of the liquid. 50 ml of chicken fat biodiesel heated in a flash point measuring apparatus. The temperature was noted continuously with a thermometer. The obtained flashpoint of chicken fat biodiesel was 174 0C. This satisfies ASTM standard .ASTM standard value is (minimum 100 0C).

Fire point

Fire point is the temperature of a fuel vapour, if once lit with the flame, will burn steadily at least for 5 seconds. Flash point is a good indication of the relative flammability of a fuel. 50 ml of chicken fat biodiesel was heated in a fire point measuring apparatus. The temperature was noted by a thermometer. The vapour was exposed to naked flame and the temperature at which the fuel vapour burns continuously for at least 5 seconds was noted. The obtained value was 185^0C.

2. TEST RIG SET UP

ENGINE

Load test was conducted on MITSUBISHI KUBOTA diesel engine. The specifications of the engine are

Manufacturer	:	MITSUBISHI KUBOTA
Number of cylinders	:	1
Number of strokes	:	4
Rated Power	:	5 HP
Rated Speed	:	1500 rpm

Bore x Stroke	:	61.5 mm x 58 mm
Cooling type	:	Water Cooled
Loading type	:	Rope brake drum loading
Brake drum diameter	:	300 mm

FIGURE 1: TEST RIG SET UP

Emission analysis depends on the exhaust gas temperature. To measure exhaust gas temperature K type thermocuple was used.

EXHAUST GAS ANALYSER

1. AVL 444 DIGAS ANALYSER

FIGURE 2 : AVL 444 DIGAS ANALYSER

Table 1: Details of AVL 444 DIGAS ANALYSER

PARAMETER	MEASURING RANGE	RESOLUTION
CO	0-10% Vol	0.01% Vol
CO_2	0-20% Vol	0.1% Vol
HC	0-20000 ppm Vol	<= 2000: 1 ppm Vol > 2000: 10 ppm Vol
O_2	0-22% Vol	0.01% Vol
NO_X	0-5000 ppm Vol	1 ppm Vol

III RESULTS AND DISCUSSIONS

The exhaust gas is analysed using AVL 444DIGAS analyser. The results obtained are tabulated and various characteristics graphs where plotted for different parameters against brake power at various load conditions.

1. **HC Emission**

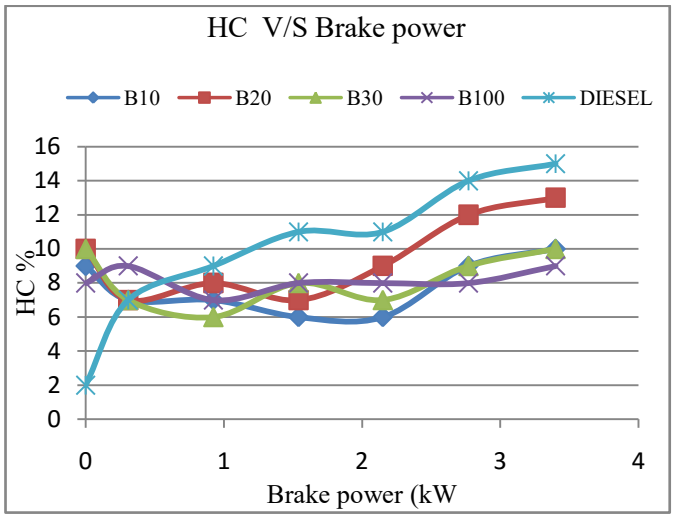

FIGURE 3: HC EMISSION

The graph shows the variation of unburned hydrocarbon emission of diesel biodiesel and its blends in the CI engine with brake power. It is seen that neat biodiesel operation emits lower HC compared to all other fuels. The amount of oxygen particle during combustion will increase the oxidation process. There is more oxygen chemically bounded within the biodiesel which is act as additional source of oxygen other than present in the intake air. This oxygen helps for the formation of air fuel mixture and its take part complete combustion. The intensity of HC emission is increasing as the quantity of diesel increases in the blends. This is due to less quantity of oxygen in the blends.

2.NO_X Emission

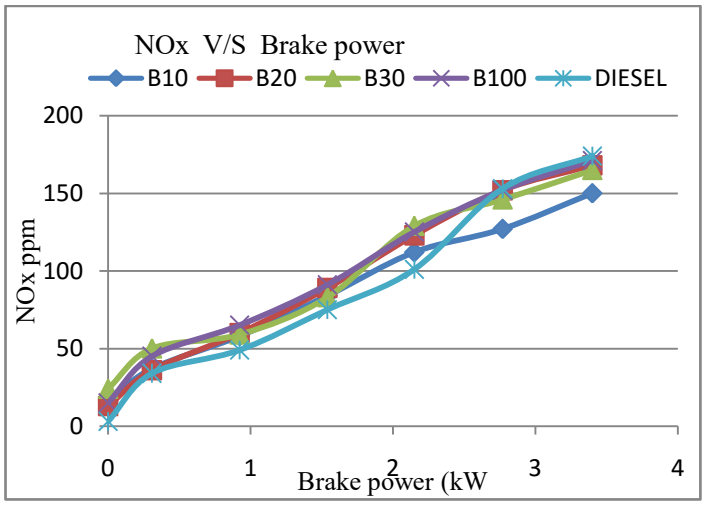

FIGURE 4: NO_X EMISSION

The figure shows the variation of NOxemission of diesel,biodiesel and its blends on the CI engine with brake power. Diesel fuel and other fuels are shows similar nature in

the NOx emission. The NOx emission decreases when the diesel content in the blends decreases. Here the NOx emission for diesel-174ppm, B100- 171ppm, B20-168ppm, B30-165ppm, B10-150ppm at full load conditions.The increase in NOx is due to the higher intensity of premixed combustion. The higher premixed combustion is due to higher cetane number of biodiesel which initiates combustion early. Also the fuel is burned quickly due to its higher oxygen content. The decrease of NOx is may be poor mixing of fuel and air which leads to decrease the premixed combustion.

3.**COEmissiom**

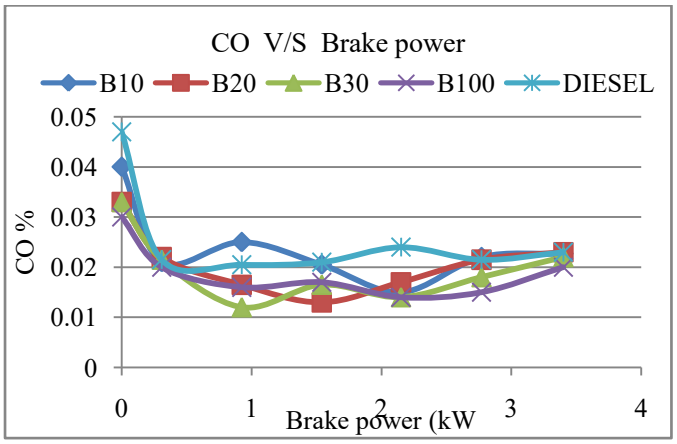

FIGURE 5: CO EMISSION

The CO emission of B100, B30, B20, B10, DIESEL are plot against the brake power. From the graph which can be seen that as load increases CO emission decreases. The CO_2 emission increases with increase in load there by the CO emission reduces. All the carbon that are available are converting into the co2 so the rests are coming out as CO. B20 and DIESEL fuel are showing the maximum CO emission 0.23%

4.CO_2 Emission

The below figure shows the variation of CO_2 emission with brake power for various blends of biodiesel and diesel. For all fuels the CO_2 emissions are similar in nature yet the maximum value of CO_2 emission is B100 and followed by B30 fuel. It is due to the presence of oxygen in pure biodiesel and the B30 blend. So the oxygen contributes in better mixing rate and leads to better oxidation of fuel which results complete combustion and the emission of CO_2.

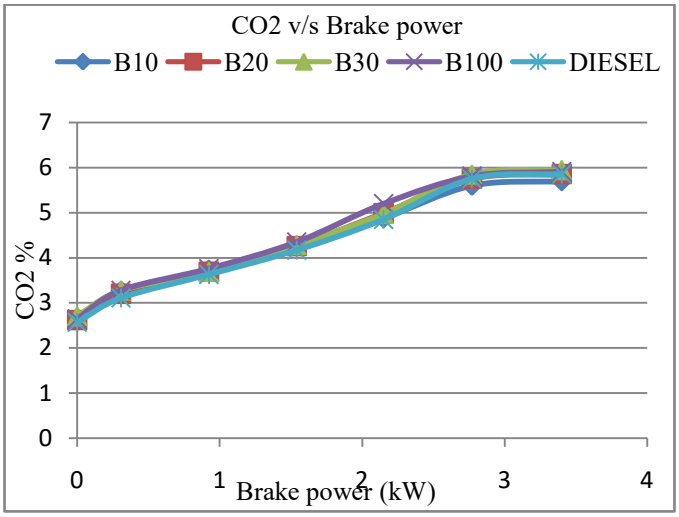

FIGURE 6: CO_2 EMISSION

5.O_2 Emission

The percentage of oxygen present in in the exhaust emission of biodiesel and its blends are shown above. The values for B100 and B30 are slightly higher than that of diesel at full load condition. The values of B20 and B10 are also comparable with pure biodiesel. Lowest oxygen emission is from diesel fuel.

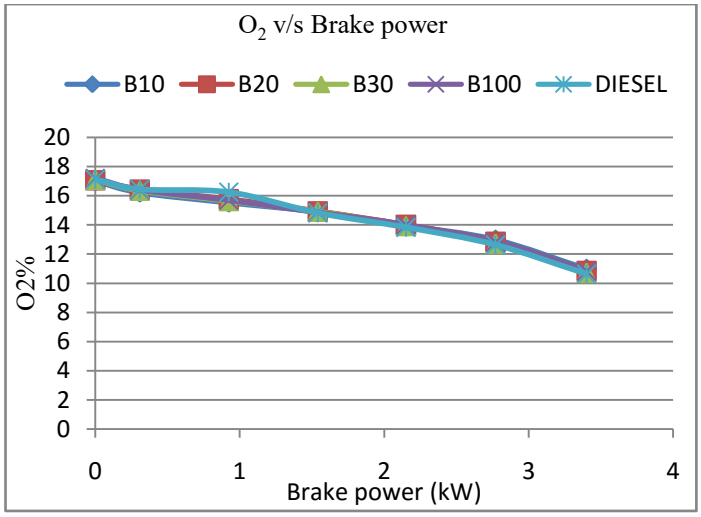

FIGURE 7: O_2 EMISSION

The presence of higher oxygen in the pure biodiesel and its blends will act as the source of additional oxygen supplier during the combustion. The additional oxygen after combustion of fuel comes as oxygen through the exhaust.

6.EXHAUST GAS TEMPARATURE

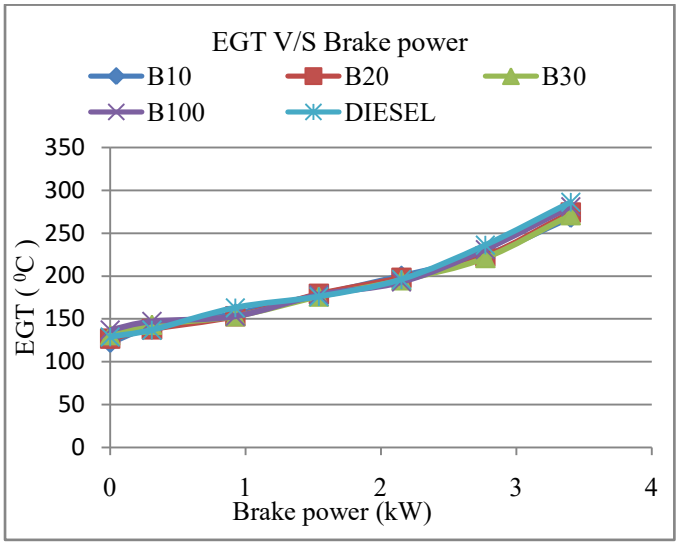

FIGURE 8: EXHAUST GAS TEMPERATURE

As far as the efficient combustion is concerned, exhaust gas temperature is an important parameter. The exhaust gas temperature increases with increase in load. The values of neat biodiesel and its blends are lesser compared to diesel at full load condition. But they are all have similar values of EGT. The temperatures for diesel 286^{0}C, B100 281^{0}C, B20 274^{0}C, B30 271^{0}C, B10 268^{0}C.

IV CONCLUSIONS

The following are the conclusions based on the experimental results obtained while operating a single cylinder diesel engine fuelled with biodiesel from rendered chicken oil and its diesel blends.

- Exhaust gas temperature is lower with pure biodiesel as compared to diesel due to early combustion
- The NOxemission are high with diesel compared to pure biodiesel and similar to B20 blend. The NOx emission decreases as the amount of diesel in the blends goes down.
- The unburned hydrocarbon emission of diesel fuel is larger as compared to the pure biodiesel and its blends.
- CO emission is very much low in the case of pure biodiesel and high for diesel fuel. Load increases the emission reduses.
- CO_2 emission is increases with increase in load.B100 and B30 shows maximum CO_2 emission. So the best combustion are takes place in lends than diesel fuel.
- Oxygen emission is inceases with increasing load.

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VI REFERENCE

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